IDS-NF Acceleration Scenario Discussion Summary

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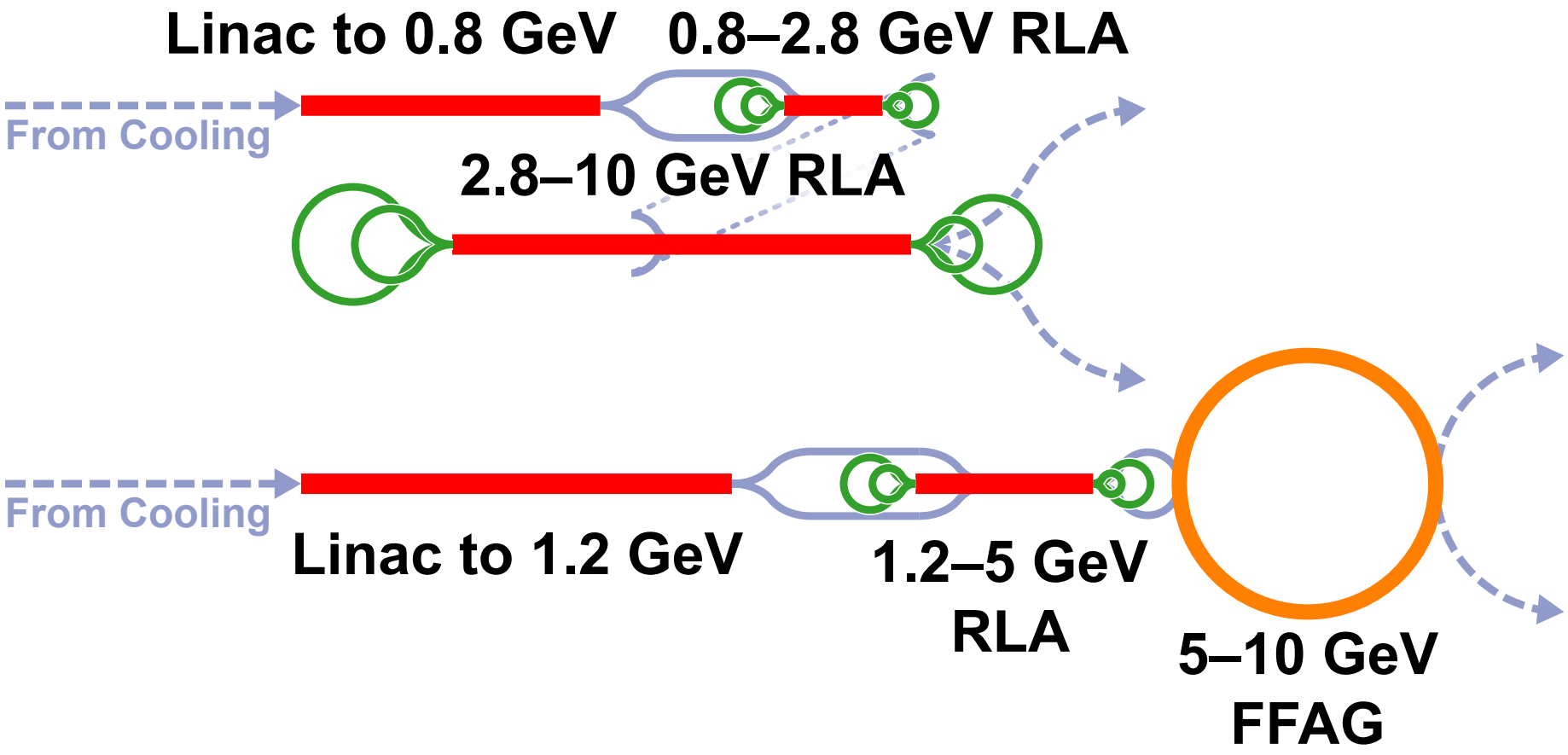
Basic Question

- Acceleration to 10 GeV
- Two possible acceleration scenarios
  - Linac → RLA → RLA
  - Linac → RLA → FFAG
- Cost neutral when breakpoints are
  - Linac → 0.8 GeV → RLA → 2.8 GeV → RLA
  - Linac → 1.2 GeV → RLA → 5.0 GeV → FFAG
- No clear performance advantage of either system
  - FFAG has known tracking issues, but comparable issues have not been verified in Linac → RLA chain.
- Choice is "gut feeling"
  - Additional type of system (FFAG) may increase operational difficulty

Acceleration Scenarios



Energy Breakpoints

- 4 GeV is a good breakpoint for physics
- We decided to choose this for a breakpoint
  - Linac/RLA work can begin since first two stages independent of choice for last stage
    - Though may have longitudinal matching differences depending on last stage
- Question: can we still get 4.5 RLA passes with reduced energy range in final stage?

Points of Disagreement

- Can one get more turns than I specify and still have reasonable longitudinal behavior?
  - Can adding nonlinearities allow more turns?
    - Without impacting dynamic aperture too much!
- Is the additional cost of increased FFAG range offset by the reduced cost of earlier stages?
- Can adding nonlinearities improve nonlinear longitudinal/transverse coupling to the extent that we can get away with less RF voltage per cell?
- Extensive design and simulation work required
- Agreed to deadline of beginning of January to do calculations and decide.

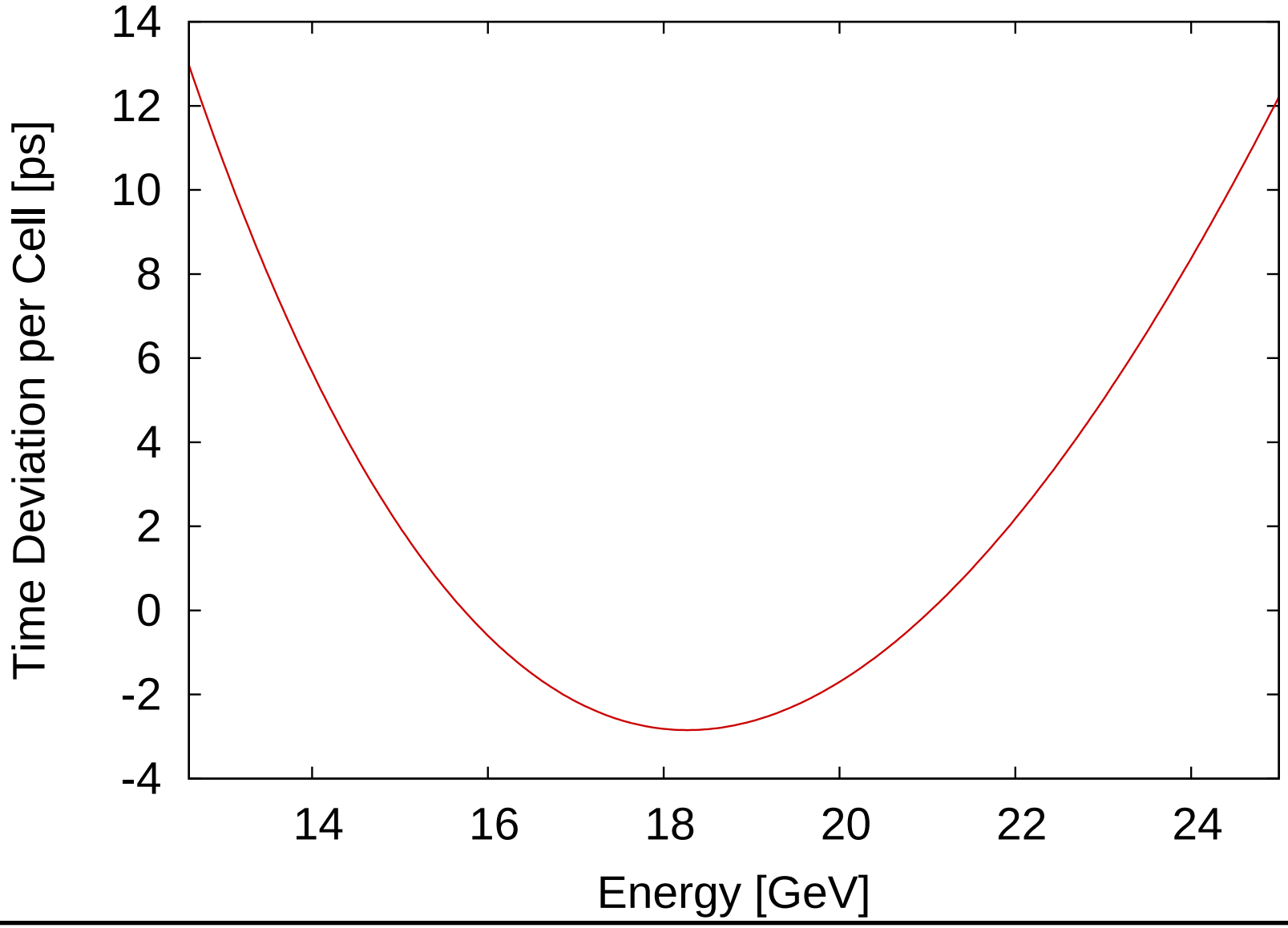
Quick 4–10 GeV FFAG Design

Min Energy (GeV)	5	4
Max Energy (GeV)	10	10
Long drift (m)	4.3	4.3
Cells	55	83
Cavities	38	66
Turns	6.4	4.1
Circumference	492	742
Max D field (T)	3.9	2.8
D radius (mm)	175	203
Max F field (T)	3.0	2.4
F radius (mm)	205	241
Energy gain/cell (MV)	14.2	17.4
Cost (A.U.)	130	206

Quick 4–10 GeV FFAG Design

- Big penalty from increasing time of flight range
- Results because increased energy range results in increased time of flight range
  - Time of flight quadratic function of energy deviation
  - Scaling seems worse than I expected
    - Scaling naively expected product of cell ratio and inverse turn ratio to be about 1.6.
    - Maybe increasing energy on low side was the problem
  - Hope to reduce time range with nonlinearities

Quick 4–10 GeV FFAG Design



Cost Estimates

Min E	RLA 2.8 GeV	FFAG 5 GeV	RLA 4 GeV	FFAG 4 GeV
Linac	10.0	14.0	12.0	12.0
RLA 1	14.8	22.5	19.2	19.2
RLA 2	35.8		29.8	
FFAG		23.3		36.9
	60.7	59.8	61.0	68.1

- Costs difference still a wash within errors
- No serious penalty for breakpoint change for RLAs
  - Assuming 4.5 turns possible in RLA 2
- But FFAG going the wrong way